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A new deep-water spatangoid echinoid from the Cretaceous of British Columbia, Canada

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Synopsis. A new species of spatangoid echinoid, *Plesiaster vancouverensis*, is described from continental slope debris flow deposits of latest Santonian to early Campanian age on Vancouver Island, British Columbia.

INTRODUCTION

The fossil record of echinoids is overwhelmingly dominated by species of the continental shelf. Although some of these lived in relatively deep water settings, such as the faunas of the North-West European Upper Chalk facies (Smith & Wright 1989, 1990, 1993), or the shelf marginal faunas of Spain (Neraudeau & Floquet 1991) or Tunisia (Zhagbib-Turki 1989), records of continental slope and basin faunas remain extremely rare. Bather (1934) described the holasteroid *Chelonechinus* from the Miocene deep-water Suva Formation of Java, and more recently a diverse bathyl echinoid fauna has been discovered in the early Miocene Morozaki Group of Japan (Mizuno 1991) and the Middle Miocene Tatsukuroiso Mudstone of NE Honshu, Japan (Kikuchi & Nikaido 1985). Pliocene deposits of California have also yielded what appear to be bathyl echinoids (Woodring 1938). Here we describe a new spatangoid from late Cretaceous outer shelf to upper continental slope deposits of western Canada.

The new species described here comes from a single horizon within the Upper Cretaceous Nanaimo Group. The Nanaimo Group represents a major sedimentary sequence within the Georgia Basin of south-western British Columbia and was deposited in a fore-arc basin along the western margin of the Canadian continental margin (England 1989). Depositional environments represented within this group range from alluvial to continental slope facies, with the echinoids coming from within a series of debris flows interpreted as upper continental slope facies.

The echinoid horizon was discovered in May 1993 by Dr A. McGugan and Dr. T. England during reconnaisance of the French Creek area. The echinoids were found in a stream section adjoining Hildegard Farm on French Creek, *ca.* 1 km upstream from Highway 4 bridge at Coombs, which crosses French Creek approximately seven km due south of Qualicum Beach, Vancouver Island, British Columbia (Fig. 1). The succession at this locality begins with *ca.* 6 m of bedded shales, siltstones and mudstones of the Haslam Formation (= lower part of the Trent River Formation of England, 1989; Fig. 2). These are overlain by a chaotic conglomeratic debris flow (McGugan, 1992). The matrix is a silty mudstone and included pebbles are a mixture of undated meta-volcanics, argillites, Cretaceous calcareous concretions (some with plant remains), sandstone and siltstone clasts, and many clasts of bedded shale, some up to 4 m in length and showing plastic deformation and slump-roll-type leading edges. The fauna of these beds include foraminifera, ammonites and inoceramid and other bivalves.

The echinoids, all of which belong to the same species, came from a single bedding plane near the top of the bedded shale series. They are preserved in life orientation and some at least retain associated spines. These echinoids were thus not transported, but lived and died within the environment of deposition represented by the shales. Since the bedded shales are overlain by debris flows, the environment of deposition is taken to be upper continental slope.

The dating of the echinoid level is based on the benthic foraminifera, which are indicative of the *Inoceramus (Sphenoceramus) schmidti* Zone, latest Santonian to Lower Campanian. The associated macrofauna also support a late Santonian – early Campanian age. A molluscan fauna (Table 1) is associated with the echinoids and in the beds immediately overlying, and has been identified by Dr. J.W. Haggart (Geological Survey of Canada, Vancouver). This includes *I. (S.) schmidti,* which is known to range from the latest Santonian to early Campanian in British Columbia and Northern California (Haggart, 1984).

Table 1. Fossil molluscs found in association with *Plesiaster vancouverensis* sp. nov. in the Haslam Formation of French Creek, Vancouver Island. Identifications by J.W. Haggart (Canadian Geological Survey, Vancouver).

Bivalves:
Inoceramus (Sphenoceramus) schmidti Michael
I. ex. gr. *subundatus* Meek
Acila (Truncacila) demessa Finlay
Ammonite:
Canadoceras yokoyamai (Jimbo)

SYSTEMATIC DESCRIPTION

Class **ECHINOIDEA** Leske, 1778
Order **SPATANGOIDA** Claus, 1876
Family **MICRASTERIDAE** Lambert, 1920
Genus ***PLESIASTER*** Pomel, 1883

TYPE SPECIES. *Micraster peini* Coquand, 1862.

OTHER SPECIES INCLUDED. *P. cotteaui* Gauthier.

OCCURRENCE. Late Coniacian to early Campanian of North Africa and North America.

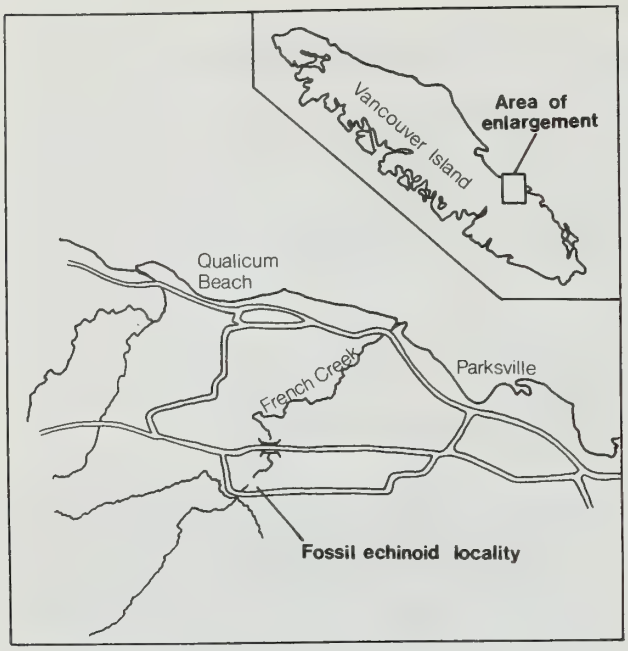


Fig. 1. Map showing the location of the echinoid bed, with insert showing its position on the island of Vancouver.

Plesiaster vancouverensis sp. nov. Text-figs 3–5

TYPES. Holotype, BMNH EE 5078 (Figs 3A, 4A, 4B, 5A); paratypes, BMNH EE5076 (Fig. 3C), EE5077, EE5079-83 (Figs 3B, 3D, 3E, 4C-F, 5B).

OCCURRENCE. Shales towards the top of the Haslam Formation (= lower part of the Trent River Formation), *I. (S.) schmidti* Zone, uppermost Santonian to lowermost Campanian, exposed in river bank of French Creek behind Hildegard Farm, *ca.* 1 km upstream from the highway 4 bridge over French Creek at Coombs, and 7 km due south of Qualicum Beach, south-eastern Vancouver Island, British Columbia, Canada.

DIAGNOSIS. A species of *Plesiaster* with a well-developed peripetalous fasciole around the posterior part of the test, a broad and strongly petaloid anterior ambulacrum, and with lateral and posterior petals broad and open, extending most of the distance to the ambitus. The contact between the labral plate and sternal plates is strongly offset towards the left-hand side.

DESCRIPTION. All tests are crushed so accurate dimensions cannot be given. The largest and best-preserved specimen is approximately 63 mm in length and 58 mm in width. Test height and shape in profile are unknown, but the test appears to have been relatively low and gently domed. The test is oviform in outline with the posterior slightly truncated. The widest point on the test lies a little behind the anterior petals at approximately mid-length.

The apical disc is ethmophract with all four genital plates similar in size and each bearing a gonopore (Fig. 3B). The posterior genital plates are not separated by the madreporite. The apical disc lies anterior of centre, 39% of test length from the anterior border.

All five ambulacra are strongly petaloid adapically. Petals are broad and sunken and remain open distally. The anterior petal extends 80% of the distance to the ambitus. It shallows and more or less disappears towards the ambitus so that the anterior is hardly notched. There are *ca.* 45 pore-pairs in a column at 63 mm test length. The pore-pairs are conjugate, with individual pores widely separated (Fig. 3A). The perradial zone is smooth and approximately as broad as a single pore-zone (Fig. 5B). The lateral petals extend 90% of the distance to the ambitus and are strongly petaloid, tapering slightly towards the ambitus. They diverge from one another at an angle of 135°. There are *ca.* 55 pore-pairs in a column at 63 mm test length. Individual pores are strongly elongate and conjugate, with successive pore-pairs separated by single rows of miliary tubercles. The posterior petals are similar, but extend only 75% of the distance to the ambitus. They diverge from one another at an angle of 50°. Pores below the petals are single. Around the peristome there are three to five enlarged phyllode pores.

Interambulacra are slightly raised adapically but do not form sharp keels. They remain biserial to the apex. On the oral surface the primibasal plates in interambulacra 1 and 4 are occluded from the peristome border by proximal ambulacral plates (Fig. 3B). The labral plate is elongate and narrow, more than twice as long as broad. The sternal plates are clearly differentiated, but unequal in size; that towards ambulacrum I being smaller and either just in contact with the labral plate (Fig. 3E) or separated from it (Fig. 3D).

The peristome is small and D-shaped; the labral plate does not project over the mouth and there is no distinct lip. The front of the peristome lies 19% of the test length from the anterior border. The periproct is crushed in all specimens. It lies on the posterior surface and is probably hidden in both apical and oral views.

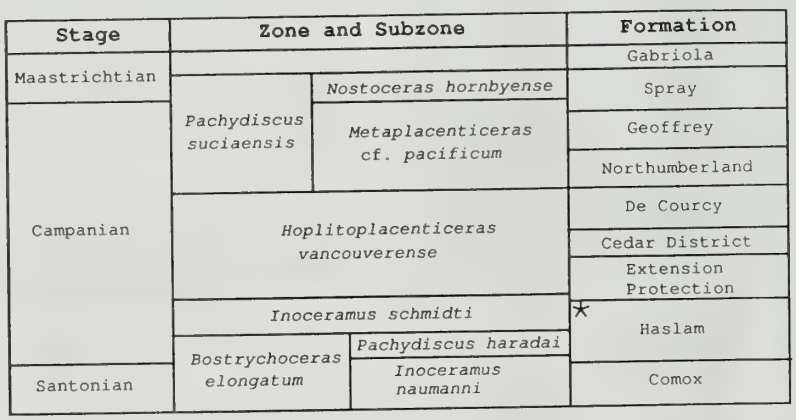


Fig. 2. Stratigraphic column for the Upper Cretaceous Nanaimo Group showing the level of the echinoid bed (*) (taken from Muller & Jeletzky 1970, and England 1989).

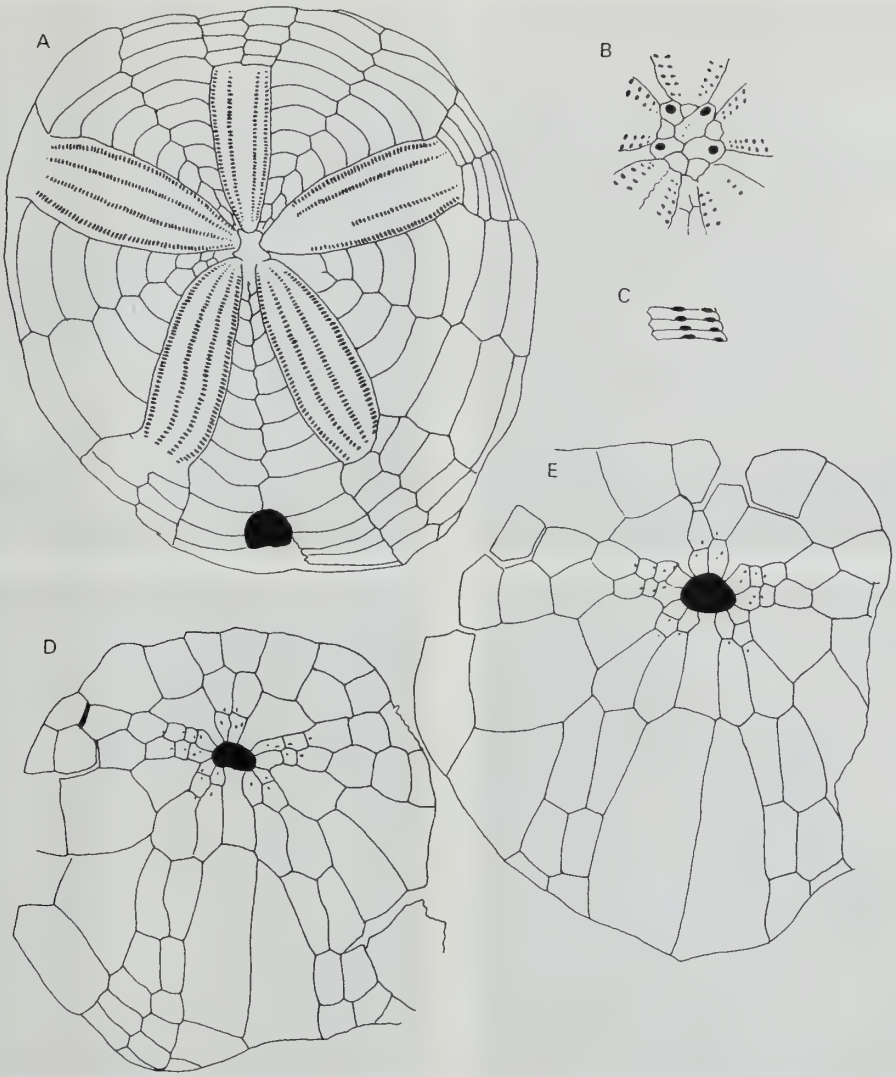


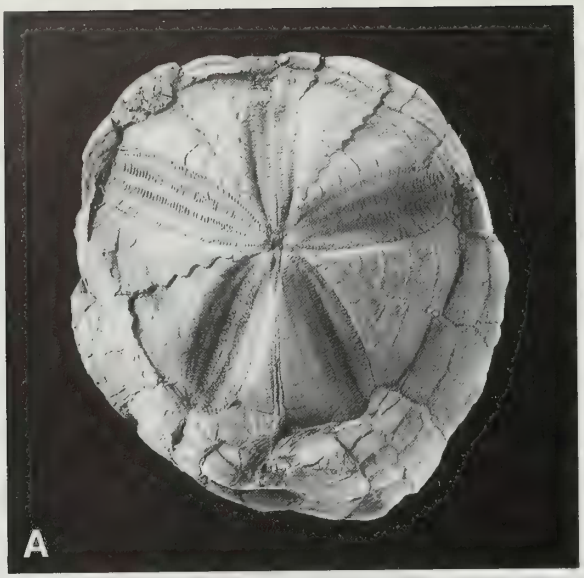
Fig. 3. Camera lucida drawings of *Plesiaster vancouverensis* sp. nov. uppermost Santonian; Lower Campanian, *I (S.) schmidti* Zone, French Creek, Vancouver Island, British Columbia. **A**, BMNH EE5078; **B**, BMNH EE5083; **C**, BMNH EE5076, **D**, BMNH EE5079; **E**, BMNH EE5081.

Tuberculation is relatively coarse on the aboral surface, with scattered primary tubercles (crenulate and perforate) up to 0.6 mm diameter set amongst a fine granulation of miliary tuberculation (Fig. 5B). A well-developed peripetalous fasciole, with up to 12 lines of densely spaced (hexagonally packed) miliary tubercles, is developed around at least the posterior of the test. It runs immediately beneath the ends of the petals and is indented in the posterio-lateral interambulacra. Unfortunately, most specimens are preserved as internal moulds so it is impossible to tell whether the fasciole continues around the anterior of the test. It is also impossible to tell whether there was a subanal fasciole present.

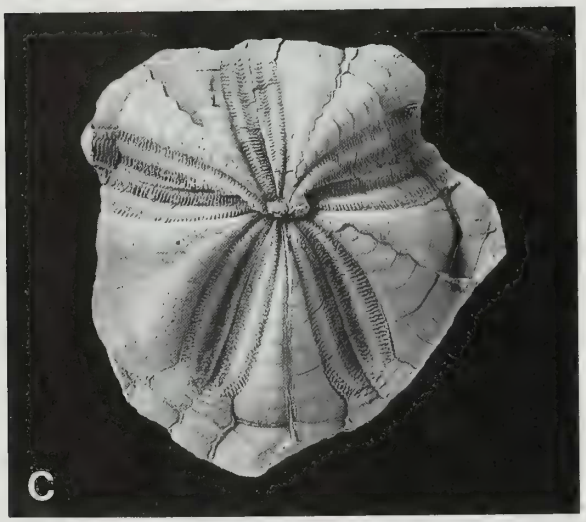
Some specimens have scattered primary spines preserved flattened against the test surface.

REMARKS. The new species is placed in the genus *Plesiaster* on account of its peripetalous fasciole and petaloid anterior ambulacrum. Only a few spatangoid genera have petaloid anterior ambulacra, namely *Douvillaster* Lambert, 1917, *Plesiaster* Pomel 1883, *Heterolampas* Cotteau 1862, *Isomicraster* Lambert 1901 and *Barnumia* Cooke 1953. Neither *Douvillaster* nor *Isomicraster* have fascioles and thus differ significantly from the Canadian species. *Barnumia* can also be dismissed from consideration since its fasciole is not peripetalous but lateral, extending around the ambitus and well-separated from the base of the petals. The type species of *Heterolampas*, *H.maresi* Cotteau, has a narrow but continuous peripetalous fasciole and petaloid ambulacra. However, it differs significantly from the Canadian species in its labral and apical disc structure. The apical disc of *H. maresi*, though ethmophract, is composed of an enlarged madreporite plate which occupies the centre of the disc and separates the posterior two genital plates. Its labral plate is large and broadly triangular, firmly abutting both sternal plates. Finally, the peristome of *H. maresi* lies considerably further back from the anterior than that of the new species.

Plesiaster Pomel, 1883, was established for *Micraster*-like forms with a partial peripetalous fasciole developed at the base of the petals. Zhagbib-Turki (1987) has given a recent analyses of the North African species and concluded that *Plesiaster* should be placed in synonymy with *Micraster*. However, the differentiation of


A


B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E


F

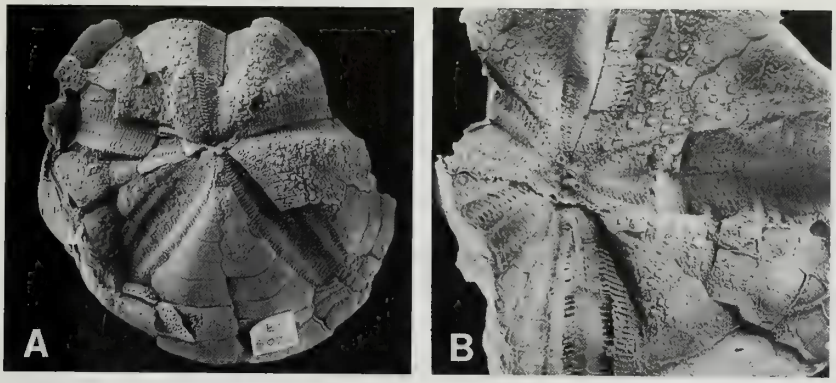

Fig. 5. *Plesiaster vancouverensis* sp. nov. **A**, BMNH EE5076, adapical view of test showing tuberculation style, ×1. **B**, BMNH EE5083, latex cast of external mould showing apical disc and tuberculation style, ×2.

a partial peripetalous fasciole represents an apomorphy for the genus and the distinction is maintained here. The European species that have been assigned to this genus in the past, *P. bucardium* Goldfuss, *P. coravium* Schlüter, *P. parvistella* Schlüter, and *P. minor* Schlüter (e.g. Ernst 1972), differ significantly from the North African type, *P. peini* Coquand. The European species all have short petals, non-petaloid anterior ambulacra, and complete peripetalous and subanal fascioles. They are placed in the genus *Diplodetus* Schlüter 1900. The two North African species, *P. peini* and *P. cotteaui* have much longer petals and incomplete fascioles.

The Canadian species comes close to *'Micraster' americanus* Stephenson in form, but differs from that species in having a much more strongly petaloid anterior ambulacrum. In *M. americanus* the pores in the anterior ambulacrum are small and separated by a raised interporal granule, whereas those pores in *P. vancouverensis* are conjugate and widely separated from one another in each pair. Furthermore, the petals of *P. vancouverensis* are larger, more open and extend closer to the ambitus than they do in *M. americanus*.

P. vancouverensis differs from the North African species of *Plesiaster* in having a well-developed peripetalous fasciole around the posterior of the test. *P. peini* and *P. cotteaui* both have very impersistent fascioles that are really only present at the base of the petals and do not form a continuous band around the posterior.

REFERENCES

Bather, F.A. 1934. *Chelonechinus* n.g., a Neogene urechinid. *Bulletin of the Geological Society of America*, **45**: 799–876.

Cooke, W.B. 1953. American Upper Cretaceous Echinoidea. *United States Geological Survey Professional Paper*, **254–A**: 44pp. 16 pls.

England, T.D.J. 1989. Lithostratigraphy of the Nanaimo Group, Georgia Basin, southwestern British Columbia. *Geological Survey of Canada Paper*, **89–1E**: 197–206.

Ernst, G. 1972. Grundfragen der Stammesgeschichte bei irregularen Echiniden der nordwesteuropaischen Oberkreide. *Geologishes Jahrbuch*, **A4**: 63–175.

Haggart, J.W. 1984. Upper Cretaceous (Santonian-Campanian) ammonite and inoceramid biostratigraphy of the Chico Formation, California. *Cretaceous Research*, **5**: 225–241.

Kikuchi, Y. & Nikaido, A. 1985. The first occurrence of abyssal echinoid *Pourtalesia* from the Middle Miocene Tatsukuroiso Mudstone in Ibaraki Prefecture, northeastern Honshu, Japan. *Annual Report of the Institute of Geosciences, the University of Tsukuba*, **11**: 32–34.

McGugan, A. 1992. Cretaceous submarine debris flow outcrops. *Geological Society of America Today*, **2**: 57 only.

Mizuno, Y. 1991. Fossil echinoderms from the early Miocene Morozaki Group in the Chita peninsula, central Japan. *In* Yanagisawa, T., Yasumasu, I, Oguro, C, Suzuki, N. & Motokawa, T. (eds), *Biology of Echinodermata: Proceedings of the seventh international echinoderm conference, Atami/9–14 September, 1990*, p. 582 only. A.A. Balkema, Rotterdam.

Muller, J.E. & Jeletzky, J.A. 1970. Geology of the Upper Cretaceous Nanaimo Group, Vancouver Island and Gulf Islands, British Columbia. *Geological Survey of Canada Paper*, **69–25**: 1–77.

Neraudeau, D. & Floquet, M. 1991. Les échinides Hemiasteridae: marqueurs ecologiques de la plate-forme castillane et navarro-cantabre (Espagne) au Cretacé superieur. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **88**: 265–281.

Pomel, A. 1883. *Classification methodique et genera des echinides vivants et fossiles*. Alger, Paris, 120 pp.

Smith, A.B. & Wright, C.W. 1989. British Cretaceous echinoids. Part I, General introduction and Cidaroidea. *Monographs of the Palaeontographical Society, London*:1–101, pls 1–32 (publication number 578, part of volume 141 for 1987).

—— & —— 1990. British Cretaceous echinoids. Part 2, Echinothurioida, Diadematoida and Stirodonta (1, Calycina). *Monographs of the Palaeontographical Society, London*: 101–198, pls 33–72 (publication number 583, part of volume 143 for 1990).

—— & —— 1993. British Cretaceous echinoids. Part 3, Stirodonta, part 2 (Hemicidaroida, Arbacioida and Phymosomatoida, part 1). *Monographs of the Palaeontographical Society, London*: 199–267, pls 73–92 (publication number 593, part of volume 146 for 1993).

Woodring, W.P. 1938. Lower Pliocene Mollusks and echinoids from the Los Angeles Basin, California. *United States Geological Survey Professional Paper*, **190**: 1–65, pls 1–9.

Zhagbib-Turki, D. 1987. Les Echinides du Cretacé de Tunisie. Paléontologie generale: systématique, paléoecologie, paléobiogeographie. Unpublished Ph. D. Thesis, Faculté des Sciences de Tunis. 613 pp, 25 pls.

—— 1989. Les échinides indicateurs des paléoenvironments: un exemple dans le Cénomanien de Tunisie. *Annales de Paléontologie*, **75**: 63–81.

Fig. 4. *Plesiaster vancouverensis* sp. nov. uppermost Santonian; Lower Campanian, *I (S.) schmidti* Zone, French Creek, Vancouver Island, British Columbia. **A, B,** BMNH EE5078 (internal mould), holotype: **A**, apical view; **B**, oral view. **C,D,** BMNH EE5081 (internal mould), paratype: **C**, apical view; **D**, oral view. **E, F,** BMNH EE5079 (internal mould), paratype: **E**, apical view; **F**, oral view. All ×1.